Executive Summary

The Houston Department of Health and Human Services through its Bureau of Pollution Control and Prevention (Houston) conducted a comprehensive survey project of emissions from a combined petroleum refinery and chemical plant complex in the Houston Ship Channel area. The complex is a source of emissions of benzene and other volatile organic compounds. The project used Differential Absorption Light Detection and Ranging (DIAL), a remote sensing methodology for measuring air pollutants. The survey indicates that measured emissions from process areas and tanks exceed the emission factor estimates for benzene and VOCs. Of the 17 areas where DIAL emissions measurements were conducted, six were compared to VOC emission factor estimates and four were compared to benzene emission factor estimates. In only one process area did emission factors produce a VOC emissions estimate comparable to the DIAL measured results, which was the Catalytic Reformer-3 Unit. Emission factors used to estimate emissions from the Southwest Tanks VOCs produced the most potential underestimated emissions compared to the DIAL measured emissions, off by a factor of 132. The comparison of benzene emission factor estimates to the DIAL measured emissions produced potential underestimated emissions ranging from a factor of 5 at the Aromatics Concentration Unit/Benzene Extraction Unit area, to a factor of 93 for the tanks located south of the ACU/BEU area.

DIAL was shown to be an effective technology for the measurement of mass flux from fugitive, non-point emission sources. DIAL is limited, however, in that it can only measure the mass flux of a single compound or a class of compounds that absorb energy at a defined wavelength during a scan. DIAL cannot directly provide information on the chemical composition of a plume of pollutants, and therefore, additional analysis is necessary to fully characterize the plume's actual composition.

Additional challenges are revealed in this survey. The time period of compositional measurements may prevent characterization of temporal variations of the plume. The compositional measurement techniques are typically limited to fixed locations, usually close to ground level. Moving these analytical platforms above ground level for elevated plumes such as those anticipated for delayed coker emissions, combined with routine changes in wind direction, represents a significant challenge.

The survey also uses two other measurement techniques to explore the efficacy of using them to validate or augment DIAL measurements. The two techniques, open path Fourier transform infrared (FTIR) and a fixed point monitor on a mobile ambient air monitoring laboratory (MAAML), were routinely and simultaneously deployed with DIAL. The pairing of DIAL with these techniques takes advantage of their complementary strengths to allow for improved plume characterization with respect to mass flux and chemical composition. In this survey project, measurements from the FTIR compared better with DIAL emissions than measurements from MAAML. This project identified key factors which should be controlled, if possible, in future investigations to improve the coordinated use of these technologies as well as integration of the collected data. As a result, verification of the data using these techniques in this study is inconclusive in many cases. Most of these factors were anticipated a priori, but remained obstacles. The significance of other factors was not apparent in advance. The main factors to control for improved comparability and usability include: degree of equipment overlap with the DIAL plume, equal MAAML sample collection duration, FTIR detection limits, availability of

scan images, availability of spatially segmented DIAL concentration measurement data, availability of spatially segmented DIAL emissions measurement data, refinement of temporal molecular weight, and ability to sample at plume height. A full discussion is provided in the report.

For surveys focused on a single aromatic compound such as benzene, measurements from Ultraviolet Differential Absorption Spectroscopy (UV DOAS), can be used in a role similar to FTIR. UV DOAS measurements, also deployed during the survey for a limited time, compare well to DIAL measurements.